Technology Opportunity

Microfabricated Gas Sensors

The NASA Glenn Research Center is actively seeking industrial partners to cooperatively further the development of high-temperature sensor technology and to develop applications for hydrogen sensor technology.

Potential Commercial Uses

- Leak detection
- Rapid inspection of valve and seal integrity
- Storage tank headspace monitoring
- Pressure vessels and piping monitoring
- Electrical insulation breakdown detection
- System health monitoring
- Engine emission monitoring and control
- Industrial emissions monitoring
- Chemical process monitoring
- Safety monitoring
- Alarms for high-temperature pressure vessels and piping
- Fire detection

Benefits

- Real-world application—makes possible in situ measurement of gases relevant to safety, emissions, and chemical processing
- Rugged—functions in environments where conventional sensors are inoperable
- Economical—can be mass-produced through silicon-based device fabrication technology
- Versatile—minimal size, weight, and power consumption gives designers lots of flexibility

The Technology

High-Temperature Gas Sensors

Accurate and reliable detection of hydrocarbons, nitrogen oxides, carbon monoxide, carbon dioxide, and oxygen over a wide range of concentrations is necessary for emissions monitoring and advanced process monitoring in many industrial applications. Such sensors would operate in situ, exposed to high temperatures and harsh environments, where many conventional sensors cannot operate.

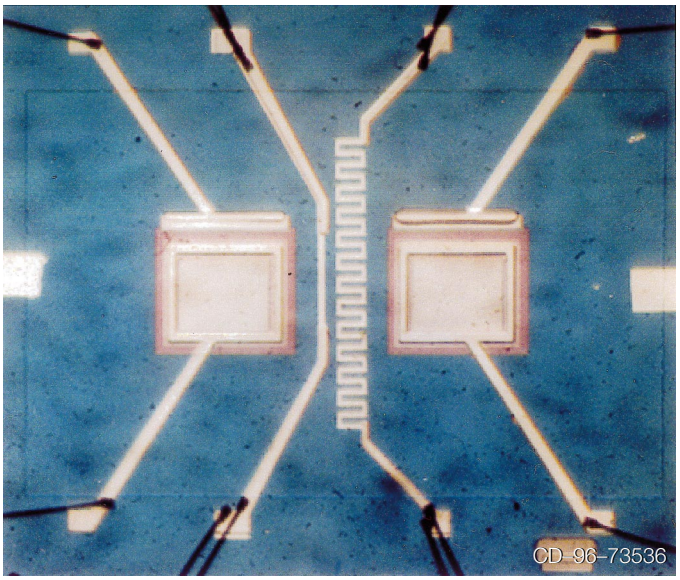

Figure 1.—Microfabricated hydrogen sensor.

NASA Glenn Research Center, in conjunction with Case Western Reserve University (CWRU), is developing a family of microfabricated high-temperature gas sensors to detect these gases. This work is based on developments in silicon carbide (SiC) semiconductor technology and microfabrication processing technology. Microfabricated sensors are small and lightweight, and they consume minimal power. They can be placed in a variety of locations to simultaneously measure gas compositions in harsh, high-temperature environments, such as inside an engine. Compared with conventional sensors, these devices often have superior high-temperature performance, chemical resistance, and mechanical toughness.

Silicon-processing technology reduces the cost of fabrication. Integration of these sensors into an array, effectively a high-temperature electronic nose, is an active project of the Glennan Microsystems Initiative.

Hydrogen Gas Sensors

NASA Glenn Research Center, in conjunction with Case Western Reserve University, has developed the technology for hydrogen gas sensors that will detect hydrogen over a wide range of concentrations (Fig. 1). There are numerous applications for such sensors, including the monitoring of flammable or explosive concentrations of gas, which is necessary for their safe use, storage, and handling.

New silicon-based microelectronic sensors that utilize a Schottky diode structure have been developed. Each sensor has a temperature detector and a heater on the same chip. The architecture of the Schottky diode makes the sensors highly sensitive to specific adsorbed gases, whereas the temperature detector and heater allow optimization of sensor response and recovery time. These microfabricated hydrogen sensors are extremely sensitive to low concentrations of hydrogen gas. A number of these sensors can be placed in a region to monitor hydrogen leaks in safety applications. With hardware and software to monitor the sensors, the operator can determine the location and magnitude of a leak.

NASA Glenn Research Center, in conjunction with Case Western Reserve University, has worked on applying these sensors in a variety of environments: from the assembly line at Ford Motor Company to demonstration flights on the space shuttle. NASA Glenn and CWRU were part of a team that received a 1995 R&D 100 Award for application of a hydrogen leak detection system on the natural-gas-powered Crown Victoria assembly line. This hydrogen leak detection system combined the hydrogen sensor technology with hardware and software to automate the inspection of automotive seals and valves on the assembled automobile.

Options for Commercialization

NASA Glenn is actively seeking industrial partners to cooperatively develop the technology and applications for the high-temperature gas sensors, which are still under development. The hydrogen sensor technology is being commercialized, and new applications are being sought for this technology.

Contacts

Commercial Technology Office
Attn: TOPS
NASA John H. Glenn Research Center
at Lewis Field
Mail Stop 7–3
Cleveland, OH 44135–3191
Phone: (216) 433–3484
Fax: (216) 433–5012
E-mail: cto@grc.nasa.gov
http://cto.grc.nasa.gov

Dr. Gary W. Hunter
NASA John H. Glenn Research Center
at Lewis Field
Mail Stop 77–1
Cleveland, OH 44135–3191
Phone: (216) 433–6459
Fax: (216) 433–8643
E-mail: Gary.W.Hunter@grc.nasa.gov
http://www.grc.nasa.gov/WWW/chemsensors/

Key Words

Hydrogen
Hydrocarbons
NO_x
Microfabricated
Sensor
Detection
Gas
Leak
Emissions
CO
CO_2

References

Patent # 5,668,301, Patent # 5,520,753,
LEW-15956-1, LEW-15956-2, LEW-16544-1,
LEW-16519-1, LEW-16243-1,
Success Story 800,314,
NASA TM–113125, NASA TM–113159, IC–040–1
CD–96–73536

National Aeronautics and
Space Administration
Glenn Research Center